smaller and much darker in color than specimens from Utah, Arizona and California. They were collected as follows: Smith's Island, Angles Bay, Gulf of Calif., June 27, 1921, male (J. C. Chamberlin); Angel de la Guardia Island, Pond Island Bay, Gulf of Calif., June 30, 1921, female, and July 1, 1921, three males and one female (E. P. Van Duzee). Mr. Van Duzee writes: "The small species from Pond Island Bay was taken on weeds and grass or even on the stones, on a rocky hillside a few feet above the floor of the valley; they have a short, sharp chirp like a house cricket only fainter, which was audible about 75 feet."

EXPLANATION OF PLATES I AND II.

PLATE I.

FIG. 1. *Tibicen chiricahua.* Type.
FIG. 2. *Tibicen chiricahua.* Allotype.
FIG. 3. *Tibicen chiricahua.* Enlarged.
FIG. 4. *Tibicen parallela.* Type.
FIG. 5. *Tibicen parallela.* Enlarged.

PLATE II.

FIG. 1. *Tibicen pruinosa.* Variety.
FIG. 2. *Okanagana nigrodorsata.* Type.
FIG. 3. *Pacarina puella.* Male from Gillette, Texas.
FIG. 4. *Pacarina puella.* Female from Victoria, Texas.

THE LIFE HISTORY OF CHIRONOMUS CRISTATUS FABR. WITH DESCRIPTIONS OF THE SPECIES.[1]

BY HAZEL ELISABETH BRANCH, PH. D.

WICHITA, KAN.

INTRODUCTION.

The study of the life cycle of this midge, the larva of which lives in waters charged with milk waste, is an outgrowth of a study in stream pollution that was conducted at Cornell University in 1920–21, the main results of which will be published elsewhere.

In the fall of 1919, Dr. P. W. Claassen of the department of Biology, Cornell University, found bloodworms growing profusely in

[1] A contribution from the Limnological Laboratories of Cornell University, Ithaca, N. Y.

a stream into which a milk plant at Adams Center, N. Y., poured its waste. These bloodworms upon being reared proved to be *Chironomus cristatus* Fabr. As the early stages of this species were undescribed, it was deemed necessary to study its life history and habits. This portion of the work was allotted to the writer, whose observations herein recorded were carried on through a period of one year.

The adults of this species are recorded by Johannsen from the states of New York, Illinois, Washington, Kansas, Idaho, South Dakota and New Jersey; and since it grows in waters of such common contamination it seems peculiar that the early stages have hitherto escaped notice. The larvæ grow readily in waters charged with milk and no difficulty has been experienced in obtaining heavy cultures and having them thrive and maintain themselves in such a medium both indoors and out.

In the indoor experiments, white enamelled steel pans of various sizes were used and in these, water was put to a depth of not less than ¾ of an inch and soil was added to cover the bottom. These pans were then stocked with either egg masses or young midge larvæ. Milk in a known proportion to the volume of water in the pan was added to these pans daily; thus the dilution for the best growing conditions was determined. The water was not changed but sufficient fresh water was added each day to maintain the original volume. By these means the conditions of a semi-stagnant pool were simulated. By screening the pans, several generations of bloodworms were raised in the same pan.

In the outdoor experiments, a sluice of about 125 feet by 3 feet and also a series of three ponds fed by pipes from this sluice were constructed. This sluice and the ponds having been artificially stocked from Adams Center, received milk waste daily. Other forms naturally found their way into these artificial breeding places but *Chironomus cristatus* Fabr. easily maintained itself as the dominant form present. It is the observations that were made under these controlled conditions that are here recorded.

LIFE HISTORY.

Eggs: The egg masses of *Chironomus cristatus* are to be found at the surface of the water attached to stones, stumps, or vegetation projecting above the surface (Plate III, Figs. 2 and 5). These egg masses

occur in the greatest abundance at points in the stream just above the pollution and where the water ripples over stones and other material. The water movement in such places probably aids aëration and lessens the silt deposits upon the gelatinous envelope of the egg mass. The newly hatched larvæ cannot dispose of as great a percentage of waste per water volume as can the grown larvæ but they require more oxygen. In the ponds and in the breeding pans where no such ripples are available, the egg masses are placed at the edges rather than upon blocks and stones placed in the open water partly submerged.

The egg mass presents a color of light brown due entirely to the eggs, for the gelatine is colorless. The shape of the mass is that of a curved and tapering cylinder. The curvature is more noticeable if the mass be floating freely and moored only by its suspensory stalk (Plate III, Figs. 1 and 3; Plate V, Fig. 30). Frequently, however, the mass comes in contact with something in the water and lies straight. The masses vary in size and measure all the way from 5 to 10 mm. in length and 1 to 2 mm. in width at the middle. The eggs are imbedded in a gelatinous ribbon in which they are set obliquely to the axis of the ribbon and this ribbon is laid back and forth, transversely, to form a hollow cylinder. As the ribbon turns on the inner and shorter edge of the cylinder, the eggs of every other row lie parallel and the adjoining rows face in opposite directions. There are approximately 34 rows of 20 eggs each in a mass, the last 2 to 4 rows being in a spiral to close the cylinder. The mass is suspended by a slender gelatinous thread, which appears like a stalk, with an attachment disc upon its outer end. This disc is not visible unless the stalk fails to adhere to some support and in this case the disc flattens and remains in the surface film and the mass floats freely in the water. Usually the egg mass is just below the surface film which it buoys up slightly above the common level. When the mass is at rest, the attachment thread or stalk is scarcely perceptible, being not more than 0.5 mm. in length; a very short distance after it enters the mass it divides into two equal strands and these traverse the length of the hollow cylinder twisting upon each other rope fashion regularly at every other row of eggs. These strands adhere to each other and to the mass at the smaller end of the cylinder (Plate V, Fig. 30). The attachment thread with its two strands and the egg mass itself are extremely

elastic and while the egg mass itself may elongate to two or three times its original length, the stalk or single thread may stretch to 50 mm. or one hundred times its normal length. When the egg mass is released from the current or whatever has caused this elasticity to show itself, the stalk, strands and mass regain their former length and position. This may be a lotic adaptation protecting the mass from dislodgment by the current. If seized it may the more easily slip out of the mouth of a devourer. There are about 525 eggs in a mass on an average based on a count of 28 egg masses (782, 735, 672, 480, 408, 374, 396, 600, 612, 720, 442, 836, 660, 680, 364, 338, 260, 384, 324, 442, 330, 1440, 378, 255, 306, 440, 510, 544); all of which were hatched and reared and proved to be *Chironomus cristatus*. The eggs measure approximately 0.28 to 0.315 mm. by 0.13125 to 0.14 mm. They taper more toward the anterior end than the posterior end, while one side is slightly flattened (Plate V, Fig. 31).

Egg laying: The female in oviposition places herself against the support chosen and balances herself by means of her middle legs and her wings which she extends and moves from time to time. The front legs are held out forward as is their natural position while the hind legs are brought under the body with the distal ends of the tibiæ almost together. The tarsi lie at a little more than a 45 degree angle with the tibiæ with the most distal segment just barely touching the surface of the water. The abdomen is curved under with the tip below the thorax and almost touching the distal ends of the tibiæ. The stalk of the egg mass appears first. It does not adhere to any support as yet but lies between the tibiæ. When this stalk has been protruded about 0.5 mm. the ribbon of eggs appears and its end is attached to the stalk and then is swayed backward and forward around the twisting strands of the stalk to form the hollow cylinder described above. The abdomen can be seen to move from side to side as the ribbon is extruded and placed in position and the tip pulsates at the extrusion of each egg. When the ribbon is nearing completion the female moves the abdomen spirally for a few turns and closes the cylinder. The attachment stalk lies between the tibiæ just barely touching them, and the tarsi support the egg mass, the outer curve of which is therefore toward them. When the mass is completed, the female rests for a moment, draws the abdomen back into normal position, lifts

her body with a movement of the wings and jerks the tarsi from under the mass and flies off. The mass usually falls so that the attachment stalk meets the support upon which the female placed herself and the mass hangs just touching the water with the surface film drawn up over it. Frequently, however, the egg mass is entirely submerged. The entire process of egg laying, from the time the female selects the place and begins balancing herself until she jerks the tarsi from under the mass, occupies about 10 minutes. The mass is very dark and small when laid upon the tarsi but when in the water it expands to twice or three times its size when extruded.

Development: In these eggs, as the chorion is very transparent, much of the embryological development may be observed. The germ cells appear at the lower pole of the egg before it is two hours old. This was first observed by Robin, 1862, and further observed by Weismann, 1865, Balbiana, 1885, and Ritter, 1890. It is the classic evidence for Weismann's theory of the continuity of the germ plasm. The incubation period is short requiring only 2 to 5 days depending directly upon the temperature. An average of eleven cases where the egg laying was observed, and exact time therefore ascertainable, was three days. This covers a period from April 22 to August 7 with a range of temperature of the water from 62 to 78 degrees Fahrenheit. When the embryo is almost mature it is spirally arranged in the compass of the egg to accommodate its increasing length, with its head toward the tapering end. When completely mature the head still retains this position but the tail is no longer in the posterior end for the body has folded upon itself and the caudal end of the embryo lies in the center. The small red eye spots, a pair on each side of the head, and the four anal gills, the caudal prominences with their six hairs each, as well as the anterior and posterior prolegs are clearly discernible.

Hatching: When the time for the breaking of the chorion is at hand, the larva moves its head up and down as far as it can reach along one side of the narrow end of the egg until a slit is made and the head crowds its way out. The larva gradually unfolds itself by pushing with its anal feet against the side of the shell opposite the slit and by pulling the body along with its anterior prolegs. The process of breaking the shell is long and the larva frequently makes several

attempts of ten to fifteen minutes duration for several (4 to 6) hours. After the shell is broken the larva may crawl out at once or it may take 15 to 20 minutes to get itself entirely free. The empty egg remains in the gelatinous matrix of the mass which disintegrates after several days. The process of hatching usually begins at the attachment end of the mass and often 24 hours may be consumed in the hatching of a mass. 99 per cent. of the eggs of a mass hatch and even in cases where the gelatinous matrix for some reason disintegrates before hatching time, the greater majority of the eggs come to maturity and hatch into strong larvæ.

Larval Life.

First Instar: At hatching, the larva is very crumpled and the lines of segmentation are confused with wrinkles. The head capsule, from the posterior margin of the dorsal line to the tip of the labrum, is from 0.1225 to 0.1575 mm. and the entire length of the larva is approximately 0.56 mm. Within the hour the larva increases in length to about 0.635 mm. and when one day old measures 1.085 mm. or almost twice its length at hatching. As a head capsule does not change its size except at moulting, we may take this constancy and the change in size as indicative of moult in determining the instars. The teeth of the labial border are more pointed in this first instar than in the later instars (Plate IV, Fig. 10). The anal gills are four in number, the ventral gills are absent. The caudal prominences possess 6 hairs each and the anterior prolegs are clothed with fine curved hairs whereas the posterior ones are fitted with many bifid claws. The color of an individual is creamy and more or less transparent and it is only when a mass of several hundred is seen that a faintly pinkish cast may be detected. For the first day after hatching the larvæ remain upon the old egg mass crawling in and out of the hollow cylinder. Upon the second day they leave the mass and by their characteristic figure-of-eight movement swim about in the water. They collect in masses upon the lighter side of objects in the breeding pans or in the streams and ponds. When three or four days old each one builds a tiny little tube by drawing together soft refuse or small particles of soil and fastening them to each other and to some support by means of a silken substance which is secreted by the larva. These tubes which may not be a millimeter in length serve as habitations and within them an

observer may see the larva undulating its body so as to cause a current of water to pass through the tube which is open at both ends. The current of water bears particles of food which adhere to the silken lining of the tube and these particles are later eaten off by the larva. Frequently a larva reverses its position so as to cause a current of water to pass through the tube in the opposite direction.

The amount of food or volume of waste per volume of water consumed in this instar is small: a thousand larvæ will not take care of more than 0.1 c.c. or 2 drops, in 300 c.c. of water each day. They will, however, thrive in this medium and keep the water clear and odorless. Out of doors the larvæ of this instar are most usually found around the edges of stones or floating particles or vegetation and along the sides of the streams or ponds.

The first instar continues over a range of 4 to 8 days with an average in 21 cases of 5.5 days. This varies with the temperature but around 65 degrees Fahrenheit it is normal to look for the moult about the eighth day. When ready to moult this first instar larva measures approximately 1.575 mm.

Second Instar: With the first moulting the ventral gills appear. They are situated upon the next to the last segment of the abdomen and are four in number, a pair at either end of the segment. They are short and stubby being no longer than the posterior prolegs. The remainder of the body is as in the first instar only larger. The head capsule measures 0.21 to 0.245 mm. The labial border still has very pointed teeth but the median tooth instead of projecting beyond the second laterals as in the first instar has come to be on a level with them and the laterals beyond the second are less lanceolate. The color of the individual has become a pinkish brown with a color in the mass of a light red. They are still attracted to the light and collect upon the brighter side of the breeding pans hanging there for hours at a time. Their tubes are longer, the old one having been merely extended, and are still transparent enough for the larva to be seen within. In this instar the food percentage may be raised to 0.2 c.c. per 300 c.c. of water for a thousand larvæ. In the outdoor experiments, the larvæ are found in deeper water and further down upon the stones and vegetation. This second instar has a duration of four to ten days with a normal of seven days. The age of the larvæ varies

from 8 to 18 days with an average of 12 days in 11 cases. Normally we look for the second moult when the larvæ are about 15 days old. When ready for its second moult the larva measures at least 3.28 mm.

Third Instar: With the second moult, the ventral gills become longer in proportion to the body, being almost twice as long as the posterior prolegs and curving slightly toward them (Plate IV, Fig. 18). The head capsule measures from 0.42 to 0.45 mm. and the color has become noticeably red. The labial border has its median tooth shorter than the second laterals but is still pointed. The second laterals are becoming more rounded and the laterals beyond the seconds are normal in shape (Plate IV, Fig. 8). The larvæ are no longer attracted to light but remain in the tubes during the day. If surprised with a bright light at night they may be seen wandering about away from their tubes. During the day they may be seen in their tubes making their undulating movements and eating the food particles from the silken lining. The tubes are built closely together even when there is plenty of room in the pan, which is contrary to the condition in the first two instars when the tubes are built far from one another. Their habits are therefore almost reversed in respect to their attraction to light and the position of the tubes. The food percentage may now be raised to 0.5 c.c. per 300 c.c. for one thousand larvæ and this is the best growing medium for a mixed lot of larvæ of all ages. The larvæ of this instar seek the bottom. The instar has a duration range of 11 to 18 days and the age of the larvæ varies from 19 to 36 days with an average of 28 days for 11 cases. We usually look for the change about the 22d day. When ready to make this moult, the larva had attained a length of approximately 5.6 mm.

Fourth Instar: In this fourth and last larval instar the individual becomes a bright red with the head almost black. The ventral gills are long and coiled upon themselves, extending backward beyond the posterior prolegs. The head capsule varies from 0.70 to 0.77 mm. and the labial border has taken on the form shown in Plate IV, Fig. 7; the second and third laterals becoming very closely applied to each other. The duration of this stage is extremely variable and at present the controlling factors are unknown. Larvæ from the same egg mass vary from 4 to 23 days, and we have a range for the beginning of pupation from 19 to 64 days after hatching with an average of 27.6

days in 23 cases. Pupation may normally be looked for when the larvæ are about five weeks old. The food content of the water should be about the same as in the third instar but they can stand a higher percentage for a few days and still keep the water clear and odorless. The variation in the length of the life of the larvæ is of economic importance for although the crests of pupation may take place at regular intervals, one may find larvæ in all stages at any one time.

Pupal Period: The transformation to pupa usually takes place in the tube but frequently one may see the full grown larvæ, which measure from 14 to 16 mm. in length, swimming about out of the tube and transforming while free from any support. The second and third thoracic segments are brown and swollen and the respiratory filaments of the pupa as well as the compound eyes may be easily seen through the larval covering of the thorax. This condition may prevail for a day or two and then the larva breaks open upon the back of the thorax and the pupa wriggles out, usually not completely extricating itself from the larval skin which covers the posterior part of the pupa (Plate V, Fig. 27). When first transformed the pupa is a bright red with very black eyes and the respiratory filaments extremely white. It remains this brilliant spectacle for about one day and then gradually turns dark and the filaments become gray. Sometimes the pupa transforms to an adult while still in a larval tube but this occurs only when the water is low. The pupa lies upon its side upon the bottom, moving only slightly for two days and then becomes extremely active swimming about by an upward and forward then downward and backward motion of the abdomen bearing now a pair of caudal paddles. The pupa holds the thorax upright and always keeps the respiratory filaments below the surface film. If the filaments do break through before the close of the period the pupa is unable to extricate itself and dies. On the third day the cuticle of the pupa becomes transparent and the body of the adult may be seen within. The pupa now swims with the body in a horizontal position just under the surface film. After swimming or floating for about one day, the pupa suddenly pushes its respiratory filaments through the surface film and stretching out upon the film becomes quiet. The whole pupal period is seldom more than 3 days.

Adult: The adult body clearly visible through the pupal skin is

now brilliant red. After a quiescent period of a few moments, the thorax suddenly bursts along the mid-dorsal line and the thorax of the adult appears. It is immediately followed by the head with the antennæ closely folded and then appears the fore part of the abdomen with the bright red wings lying along the sides of the body apparently all filled out and only needing to become dry to be useful. The middle pair of legs are drawn out first and touch the old pupal thorax at the base of the old respiratory filaments. The adult supported on these legs works the body up and down a few times and then the hind pair of legs are released and braced against the old pupal abdomen. The tip of the abdomen appears immediately and the front pair of legs come out at the same time. These legs and the wings flutter a moment and the adult flies from the water. This emergence takes about 10 to 12 seconds at times and again may be accomplished in 4 or 5 seconds. If it be prolonged beyond 12 seconds, the emergence is a failure, the tip of the abdomen and the hind legs seeming to stick.

The adult usually flies off at once but it may rest for several minutes upon the pupal skin or even upon the water, but this last may be followed by disaster. The male antennæ take shape slowly and it may be 10 or 20 minutes before he is in full plumage. The usual time for emergence is at dusk or early in the morning. Upon emergence the adults fly to the light in the indoor experiments, and straight up into the air and are lost to sight when the emergence takes place out of doors. The average time from hatching to emergence is 41 days in 26 cases with a range of 23 to 90 days. As the time of the fourth instar is variable, so is the period during which the adults from an experiment may appear, a long one. In our experiments this period extended from 10 to 81 days with an average of 32.7 days in 21 cases. The range from hatching to the last emergence for a given experiment is 27 to 118 days with an average of 71 days in 20 cases. This variation is also accountable for the continued supply of larvæ in a stream and for the presence of egg masses at almost any period of the summer.

The adults keep in dark corners and weed shelters in the day time and swarm at sunset in great masses, the males making up the greater percentage of the swarm. They move up and down in the air at various levels and remain in the air for a period of about half an hour. Fe-

males may be seen darting in and out of the swarm or sitting quietly near by. Suddenly one of these females will dart into the swarm and catch a male by the thorax with her fore legs, both individuals headed in the same direction. Instantly the male whirls about so as to head in the opposite direction and drops from the swarm carrying the female along behind. The pair drop about five feet and then, without pausing, rise again to about the level of the swarm and separate and both come to rest. In a very few moments, the male returns to the swarm but the female usually remains quiet or crawls about doing very little if any flying. Only those forms which have been emerged long enough to be thoroughly dry mate, or at least none of the mating pairs in our observations showed any red, which is the characteristic color of a newly emerged adult and the color persists for about six hours. A similar process of mating has been observed in this same genus *Chironomus plumosus* Linne by Needham.

Parthenogenesis seems not to occur in this species. Of 52 females that emerged in isolation, only 29 laid eggs and none of these were fertile.

As for the length of life of the adults, the females in captivity where their emergence was known lived an average of 4 days and 15 hours while some lived as long as 8 days. The males show an average of 5 days and 15 hours with an extreme of 17 days. As far as known, the female lays only a single egg mass.

Egg laying certainly does not take place immediately after mating as experiment records show. Three days may elapse from emergence to egg laying in unfertilized females and this same time often elapses between time of capture and the laying of eggs by a fertile female. There may therefore be approximately a week from emergence to the larval stage. This makes a six weeks cycle for the normal cases; and the observations of the crests of emergences and egg laying verify this period. We observed one crest the second week of July, which was probably the second of the season, another the fourth week of August and another the first week of October, making at least four cycles in a season. We had emergents in the indoor experiments as early as April 5th and if this were followed in the open even a week or so later there could easily be five cycles. It is not uncommon to see Chironomids flying in April and to collect eggs at that time,

but until further data is obtainable for this species we will say that there are at least four cycles for the season.

The numbers of the two sexes are about equal as determined by counts of individuals taken from the indoor rearings over a period of three months. The number reaching maturity in these experiments was only 3 per cent. for great fatalities occur at the moults and especially at the change from larva to pupa.

The species overwinters in the larval stage and is extremely resistant to freezing temperatures. Where possible the larvæ burrow into the debris and soil but may be frozen in a solid cake of ice and when thawed out become active and later pupate. They are also resistant against drought. They crawl into the mud as the water recedes; even though the dirt about them be dry enough to crack and crumble, they will revive when water is placed on them and continue their functions.

When milk particles are available nothing else is eaten or at least nothing else can be seen in stomach contents, but if this food be lacking then the larvæ will eat small green algæ. The larva apparently does not eat in temperatures below 37 degrees Fahrenheit and becomes inactive, but resumes activities at any rise in temperature.

Summary: We have therefore a species with an incubation period of not more than five days, a larval period of four instars with a range of 24 to 115 days, a pupal period of 3 days and an adult life of 4 or 5 days. The crests of emergence fall approximately six weeks apart and there are at least four, possibly five, cycles a season.

DESCRIPTIONS.

Egg Mass: Color light brown; 5 to 10 mm. in length, 1 to 2 mm. in width. Individual eggs measure 0.28 to 0.315 mm. by 0.13125 to 0.14 mm. and are set usually on a slight diagonal in a narrow gelatinous ribbon which folds back and forth upon a hollow cylinder to form the mass. There are approximately 34 rows of 20 eggs each but this is variable for the range in numbers of eggs in a mass may be from 255 to 1,440 with an average of 525. The mass may be found attached to a stone or aquatic plant at the surface of the water (usually where there are ripples) by a gelatinous stalk which, when it reaches the mass, divides into two strands which extend the length of the hollow cylinder within the center (Plate III, Figs. 1 and 3; Plate V, Fig. 30).

Larva: 14 to 16 mm. in length when full grown, of a bright red color. Head dark brown, bearing two pairs of pigment spots or superficial eyes. The antennæ about one fifth as long as the head and consisting of a large but slender basal joint with one sensory pore and bearing distally two processes, one of four joints of which the first and third are the longest, the other process not jointed and shorter. Labrum prominent and fitted with one pair of dorsal hooks situated near the median line, one pair of ventral hooks lying nearer the median line than the dorsal pair; upon each side of the labrum and toward the distal edge are three hooks longer than the dorsal or ventral pair, which are graduated in length, the longest being toward the front. The anterior comb projects laterally so as to form another pair of hooks. The teeth of the posterior comb, which is a horizontal bar, are similar in shape and size, slender, pale and pointed. The mandibles large with five teeth, the distal one pale, the others black with the one adjacent to the pale distal tooth pointed as a rule but in some cases blunt; a row of hairs upon the inner face of the mesal border of the mandible projects mesad beyond the teeth; there is a single seta near the base of the mandible but upon it. The maxillæ bear a single palpus each and this is terminated with a ring of papillæ; two setæ rise near the base of each maxilla. The labium is dark with a median tooth which is rounded and longer than the first laterals but shorter than the second laterals; the second laterals rounded and closely applied to the third laterals which appear almost as shoulders of the second (Plate IV, Fig. 7). The head shows a distinct clypeal sclerite, upon which are three pairs of setæ, and two lateral sclerites which are joined ventrally and each sclerite bears dorsally two setæ. Upon the last abdominal segment is a pair of rounded caudal projections with six hairs each. The anal gills are four in number and prominent. The ventral gills, which appear at the first moult, are four in number; situated upon the eighth abdominal segment on the ventral surface. The anal prolegs bear three incomplete rows of dark bifid claws. The anterior prolegs are closely applied to each other and move as a single process; their tips are clothed with a mass of fine, curved pale hairs. (Plate IV, Fig. 19.)

Pupa: 5 to 9 mm. in length; bright red when newly transformed, changing to almost black. Respiratory processes of numerous fine

filaments in three main tufts upon each side of the thorax, filaments white turning to grey. Abdomen, usually partially enclosed in the old larval skin, bearing a pair of caudal fins from which issue a mass of long hairs; the eighth abdominal segment bears, laterally upon its apical edge, a pair of heavily chitinized spurs which are pentafid; abdominal segments 1 to 5 are marked laterally with a dash of dark pigment (Plate V, Figs. 27–29).

Male: 5.5 to 7 mm. Front of face pale, palpi 4 jointed, darker than face; antennæ 12 jointed, dark; the basal joint subglobular, large; the second joint twice as long as broad; joints 3 to 11 twice as wide or wider than long; the 12th joint longer than all others put together; all but basal joint plumose, hairs pale and unicolored. Eyes glabrous and black. Dorsum of thorax yellow with the usual three stripes, which in this species are cinereous brown with a grayish bloom; the middle stripe divided into two by a pale median line, the stripe is continued to the scutellum by a narrow dark line. Scutellum pale; metanotum and mesosternum brown. Wings finely punctate, venation as figured (Plate V, Fig. 25) not reaching beyond the sixth abdominal segment; veins yellow, cross vein brown. Coxæ yellow, legs greenish yellow and pilose; of all legs, tips of the femora, tibiæ and first, second and third tarsal joints dusky; fourth tarsal joint sometimes all dark, fifth tarsal joint always dark; claws distinct and black. Knees of fore legs dark and basal joint of tarsi having a relation of 52:36 with tibia; fore tarsal joints bare; tip of tibia lacking a comb. Tips of tibiæ of middle and hind legs bearing an incomplete comb with two of the teeth produced into sharp dark spurs. Abdomen with cinereous brown bands which lie at the base of the segment; each band is somewhat wider at the middle where it is prolonged into a fine line sometimes reaching the posterior margin of the segment; segments 1 to 5 pale on the venter; segments 6 and 7, cinereous markings continuous upon venter; 8 and 9 without markings all palely cinereous brown; segment 9 bearing apically a pale median hook; forceps of 3 pairs and as figured in Plate V, Figs. 32, 33, 34.

Female: 5.0 to 6.5 mm. Face and palpi as in male. Antennæ 6 jointed, yellow except apical joint which is brown; the basal joint subglobular; the second apparently a fusion of two as it bears two

rows of sensory pores the basal row of which is not possessed of sensory hairs, the outline of the segment is constricted but there is no evidence of a suture; segments 2 to 5 bottle shaped, the terminal joint as long as 3, 4 and 5 combined; all joints except basal have a single row of sensory hairs. Eyes glabrous. Thorax as in male. Wings finely punctate and reaching to middle of segment 8. Legs as in the male. Abdomen broad, segments with wide cinereous band covering all but a narrow posterior margin which is pale. Segments 1 and 2 pale on the venter; 3 to 7 marked all around, 8 and 9 palely cinereous; ovipositors of one pair, pale (Plate V, Figs. 35, 36, 37).

Distribution: New York, Illinois, Washington, Kansas, Idaho, South Dakota, and New Jersey.

BIBLIOGRAPHY.

HOLMGREN, NILS (1904). Zur Morphologies des Insektenkopfes. Zeitschrift für wiss., Bd. 76.

JOHANNSEN, OSCAR AUGUSTUS (1905). Aquatic Nematocerous Diptera, II. N. Y. State Museum Bulletin, 86.

KIEFFER, J. J. (1913). Nouvelle Etude sur les Chironomidæ de l'Indian Museum de Calcutta. Rec. Ind. Mus., Vol. IX, Pt. III, July, '13.

MALLOCH, JOHN R. (1915). Chironomidæ of Illinois. Bulletin of Ill. St. Lab. of Nat. Hist., Vol. X, Art. VI.

MIALL AND HAMMOND (1900). The Harlequin Fly.

NEEDHAM, JAMES G. (1907). Notes on the Aquatic Insects of Walnut Lake. Report of the Board of Geological Survey of Michigan, 1907.

EXPLANATION OF PLATES III, IV AND V.

PLATE III.

FIG. 1. Egg masses much enlarged.
FIG. 2. Egg masses on grass, slightly enlarged.
FIG. 3. Egg mass showing characteristic arcuate shape.
FIG. 4. Larval tubes, natural size.
FIG. 5. Egg masses on a stone, natural size.
FIG. 6. A clump of larval tubes, natural size.

PLATE IV.

FIG. 7. Labial border of full-grown larva, fourth instar. 330 ×.
FIG. 8. Labial border of larva of third instar. 575 ×.
FIG. 9. Labial border of larva of second instar. 1,150 ×.
FIG. 10. Labial border of larva of first instar. 1,700 ×.

FIG. 11. Mandible of full-grown larva with fourth tooth rounded. 220 ×.
FIG. 12. Mandible of full-grown larva with fourth tooth pointed. 220 ×.
FIG. 13. Bifid claw of the anal proleg. 300 ×.
FIG. 14. Antennæ of larva, dorsal view. 210 ×.
FIG. 15. Grown larva. 5 ×.
FIG. 16. Newly hatched larva. 80 ×.
FIG. 17. Last two abdominal segments of a larva of the second instar. 45 ×.
FIG. 18. Last two abdominal segments of a larva of the third instar. 25 ×.
FIG. 19. Larva one day old. 80 ×.
FIG. 20. Lateral view of head of full-grown larva. 50 ×.
FIG. 21. Dorsal view of head of full-grown larva. 50 ×.
FIG. 22. Last two abdominal segments of a full-grown larva. 15 ×.

PLATE V.

FIG. 23. Antenna of female adult. 35 ×.
FIG. 24. Antenna of male adult. 25 ×.
FIG. 25. Dorsal view of male adult. 10 ×.
FIG. 26. Distal end of middle tibia to show comb. 100 ×.
FIG. 27. Lateral view of pupa with larval skin not completely shed. 10 ×.
FIG. 28. Spur of eighth abdominal segment of pupa. 200 ×.
FIG. 29. Caudal fins of pupa. 25 ×.
FIG. 30. Egg mass. 15 ×.
FIG. 31. A single egg. 55 ×.
FIG. 32. Genitalia of male, lateral view. 60 ×.
FIG. 33. Genitalia of male, dorsal view.
FIG. 34. Genitalia of male, ventral view.
FIG. 35. Genitalia of female, ventral view. 55 ×.
FIG. 36. Genitalia of female, dorsal view.
FIG. 37. Genitalia of female, lateral view.